INTERNATIONAL STANDARD

ISO 16000-24

Second edition
2018-12

Indoor air —

Part 24:
Performance test for evaluating the reduction of volatile organic compound concentrations by sorptive building materials

Air intérieur —

Partie 24: Essai de performance pour l'évaluation de la réduction des concentrations en composés organiques volatils par des matériaux de construction sorptifs

Reference number
ISO 16000-24:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 16000-24:2009), which has been technically revised. The main changes compared to the previous edition are as follows.

— The target chemical compounds subject to this document have been changed from “volatile organic compound (except formaldehyde)” to “volatile organic compound” specified in ISO 16000-6.

A list of all parts in the ISO 16000 series can be found on the ISO website.

Introduction

Sorptive building materials have been marketed in the form of sheet and board products for removing airborne pollutants via physical sorption or chemical reaction.

Harmonized test methods for evaluating sorptive effects are important for comparative assessment of the performance of sorptive building materials that are used for reducing levels of indoor air contaminants.

This document specifies a test method for evaluating the performance of sorptive building materials for reducing indoor air volatile organic compound (VOC) concentrations over time.

The performance of sorptive building materials is evaluated by measuring the area-specific reduction rate and the saturation mass per area and is affected by a number of factors. Specific test conditions are therefore defined in this document.

This document can be applied to most sorptive building materials used indoors and for VOCs (excluding formaldehyde).

This document is based on and is complementary to the test chamber method specified in ISO 16000-9.

Indoor air —

Part 24:

Performance test for evaluating the reduction of volatile organic compound concentrations by sorptive building materials

1 Scope

This document specifies a general laboratory test method for evaluating the reduction in concentration of VOCs by sorptive building materials. This method applies to boards, wallpapers, carpets, paint products, and other building materials. The sorption of those target compound(s), i.e. VOCs, can be brought about by adsorption, absorption and chemisorption. The performance of the material, with respect to its ability to reduce the concentration of VOCs in indoor air, is evaluated by measuring area-specific reduction rate and saturation mass per area. The former directly indicates material performance with respect to VOC reduction at a point in time; the latter relates to the ability to maintain that performance.

This document is based on the test chamber method specified in ISO 16000-9.

NOTE Sampling, transport and storage of materials to be tested, and preparation of test specimens, are described in ISO 16000-11. Air sampling and analytical methods to determine VOCs are described in ISO 16000-6 and ISO 16017-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16000-3, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method*

ISO 16000-6, *Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID*

ISO 16000-9, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

ISO 16000-11, *Indoor air — Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

ISO 16017-1, *Indoor, ambient and workplace air — Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography — Part 1: Pumped sampling*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
area-specific reduction rate
q_{ads}
mass of *target compound(s)* (3.14) sorbed per time unit per area at the specified elapsed time from the test start

3.2
breakthrough time
t_{b}
time at which the *target compound* (3.14) concentration in the air eluting from the sample tube reaches 0,5 % of the concentration in the supply air

3.3
degradation coefficient
ratio of the mass of *target compound(s)* (3.14) removed by the initial performance divided by the mass of the same compound(s) lost by deterioration

3.4
elapsed time
t_{e}
time from the start of test to the start of air sampling

Note 1 to entry: Elapsed time is expressed in hours or days.

3.5
equivalent ventilation rate per area
$q_{V,\text{ eq}}$
increased clean air ventilation rate giving the same reduction in *target compound* (3.14) concentration as the building material

3.6
guideline concentration
corresponding threshold indoor air concentration *for target compound(s)* (3.14) as specified by the WHO or an appropriate national standards body

3.7
half-lifetime
time elapsed from the start of the test until the *target compound* (3.14) concentration reduction performance decreases to one-half of the initial concentration reduction performance

3.8
lifetime
t_{lt}
time period over which the product continues to reduce *target compound* (3.14) concentrations

Note 1 to entry: The lifetime is given in days or years.

Note 2 to entry: The lifetime is estimated from the *area-specific reduction rate* (3.1) and *sorption capacity* (3.12) measured by the sample tube test.

3.9
mass transfer coefficient
k_{a}
coefficient arising from the concentrations difference between the test specimen and ambient air over its surface

Note 1 to entry: Mass transfer coefficient is expressed in metres per hour.

3.10
recovery

measured mass of *target compound(s)* (3.14) in the air leaving the test chamber with no sample present conditioned over a given time period divided by the mass of target compound(s) added to the test chamber in the same time period

Note 1 to entry: The recovery is expressed as a percentage and provides information about the performance of the entire method.

3.11
saturation mass per area

ρ_{Aa}

theoretical maximum mass of *target compound(s)* (3.14) that could be removed per area of the sorptive material

Note 1 to entry: Saturation mass per area is expressed in micrograms per square metre. It corresponds to the *total mass per area of sorption* (3.16) at the *half-lifetime* (3.7) , or is extrapolated from the *sorption capacity* (3.12) derived from the test specified in Annex A.

3.12
sorption capacity

w_S

total mass of *target compound(s)* (3.14) sorbed at *breakthrough time* (3.2) per mass of sorbent

Note 1 to entry: Sorption capacity is expressed in micrograms per gram and is measured using the test specified in Annex A.

3.13
supply air concentration

ρ_S

mass concentration of *target compound(s)* (3.14) in the air for supply to the test chamber

3.14
target compound

volatile organic compound in indoor air

3.15
test chamber concentration

concentration of *target compound(s)* (3.14) measured at the outlet of a test chamber, derived by dividing the mass of the target compound(s) sampled at the outlet of the chamber by the volume of sampled air

3.16
total mass per area of sorption

ρ_A

integral over time of *area-specific reduction rate* (3.1) from the start of the test to the specified *elapsed time* (3.4) measured with the test chamber

Note 1 to entry: Total mass per area of sorption is expressed in micrograms per square metre.

3.17
air sampling period

period of time during which air is sampled from the outlet of the test chamber using sampling tubes or other devices

4 Symbols

Symbol	Meaning	Unit
A	surface area of test specimen	square metres
q_{ads}	area-specific reduction rate per time per area	micrograms per square metre per hour
$q_{V,\,\mathrm{a}}$	air flow rate per area	cubic metres per square metre per hour
$q_{V,\,\mathrm{eq}}$	equivalent ventilation rate per area	cubic metres per square metre per hour
k_{a}	mass transfer coefficient determined using water vapor	metres per hour
L	product loading factor	square metres per cubic metre
m	actual mass of test specimen in sample tube	grams
n	air change rate	changes per hour
q_{c}	air flow rate of test chamber	cubic metres per hour
q_{s}	air flow rate of sample tube	litres per minute
t_{b}	breakthrough time	minutes
t_{e}	elapsed time	hours or days
t_{lt}	lifetime of the pollutant-removing performance	hours or days or years
V	air volume of test chamber	cubic metres
w_{s}	sorption capacity measured by sample tube	micrograms per gram
ρ_{A}	mass of sorptive material per area (surface density)	grams per square metre
$\rho_{A\mathrm{a}}$	saturation mass per area	micrograms per square metre
$\rho_{A\mathrm{c}}$	total mass per area of sorption measured by chamber test	micrograms per square metre
$\rho_{\mathrm{in},\,t}$	concentration of target compound(s) at test chamber inlet at elapsed time t	micrograms per cubic metre
$\rho_{\mathrm{out},\,t}$	test chamber concentration at elapsed time t	micrograms per cubic metre
ρ_{s}	supply air concentration in sample tube	micrograms per cubic metre

5 Principle

The performance of a building material in reducing the concentration of target compound(s), i.e. VOCs, from the indoor air, is evaluated by monitoring the reduction of the concentration inside a test chamber containing a test specimen of that material. The test assesses both the initial performance of the material and how long that performance is maintained.

In this test method, target compound-spiked air is supplied into a test chamber. The spiked air should be prepared at approximately the guideline concentration level for target compound(s) in indoor air. Reference to the WHO or an appropriate national standards body can be made if this is clearly highlighted in the test report.

Performance is determined by monitoring the difference of the inlet and outlet concentration of the test chamber. Testing should be continued for the half-lifetime, i.e. until the concentration reduction performance of target compound(s) drops to half that at the start of the test under constant ventilation conditions. This test determines area-specific reduction rate, ρ_{ads}, and total mass per area of sorption, $\rho_{A\mathrm{c}}$, at the half-lifetime. The measured $\rho_{A\mathrm{c}}$ at the half-lifetime is defined as the saturation mass per area, $\rho_{A\mathrm{a}}$.

If a test material has a long-lasting target compound reduction performance (e.g. more than 28 days) and the test might take too long a time, alternative methods specified in Annex A for determining $\rho_{A\mathrm{a}}$ may be applied.

The performance of sorptive building materials is mainly determined by the concentration of target compound(s), the mass transfer coefficient of target compound(s) to the surface, and the sorption characteristics of the building materials themselves (adsorption isotherm, diffusion resistance, and so on). Therefore, the performance test method shall specify both the concentration of target compound(s) and the mass transfer coefficient associated with the sorptive building materials.

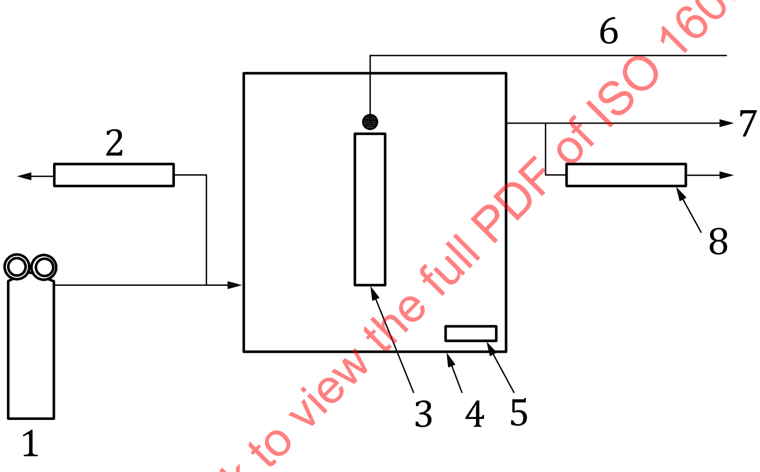
A re-emission test should be conducted following the test for evaluating concentration reduction performance, the procedure for which is described in 11.3.1.

NOTE The long-term target compound reduction performance is represented by the saturation mass per area, ρ_{Aa}, and, if necessary, the lifetime of the pollutant-removing performance, t_{lt}, as the subsidiary index.

6 Apparatus and materials

The usual laboratory apparatus and, in particular, the following.

6.1 Test chamber, complying with relevant specifications and requirements of ISO 16000-9 (see Figure 1). No air shall be allowed to circulate from the outlet back to the inlet.



Key

1	target compound(s) in spiked air (6.3)
2	air sampling device (6.6)
3	test specimen
4	test chamber (6.1)
5	device to circulate air and control air velocity
6	temperature/humidity monitoring apparatus (6.4)
7	test chamber outlet
8	air sampling device (6.6)

Figure 1 — Outline of the test chamber system

6.2 Air purifier or cylinder of clean air, to ensure the supply air before being spiked with target compound(s) is as clean as possible, i.e. it shall not contain any contaminants at levels greater than the chamber background requirements.

6.3 Supply air spiked with target compound(s), created by applying a standard gas (with known target compound concentrations). Alternatively, use a stable source to generate air spiked with target compound(s) that can be to supplied to the test chamber at a constant concentration. The stability of the spiked concentration(s) shall be monitored.

The spiked concentration(s) should be determined at least twice (at the beginning and end of the test).

6.4 Temperature and humidity monitoring apparatus.

Temperature shall be maintained either by installing a test chamber in a place maintained at a required temperature, or by maintaining a required temperature in the chamber. Relative humidity shall be maintained at the required humidity of the supply air.

6.5 Air flow meter, installed at the inlet or the outlet of the test chamber to measure the air flow rate through the chamber.

6.6 Air sampling devices, to sample the inlet and outlet air of the test chamber. When a separate sampling port is used, sample directly from the inlet or outlet of the chamber.

If a duct or tube is used, it shall be as short as possible and kept at the same air temperature as that in the test chamber. Such a duct or tube shall be made of a material with a very low sorption capacity, e.g. polytetrafluoroethylene.

The sum of sampling air flow rates shall be smaller than the air flow rate into the chamber. Sampling devices shall comply with the specifications of ISO 16000-3 and ISO 16000-6, respectively. When the air is sampled from the inlet, ensure the supply air flow rate remains constant.

A multiport sampling manifold may be used to provide flexibility for duplicate air sampling. A mixing chamber between the test chamber and the manifold or between the air inlet and the test chamber can be included to permit addition and mixing of internal standard gases with the test chamber air stream.

The exhaust from the test chamber should be ducted into a fume hood, ensuring any chemicals emitted from the test material are isolated from the laboratory environment.

6.7 Analytical instrument. For determination of VOCs, a gas chromatograph (GC) shall be used as specified in ISO 16000-6 and ISO 16017-1. Alternative devices with an equal or better accuracy may be used.

7 Test conditions

7.1 General

The test conditions shall comply with 7.2 and 7.3. This test shall be conducted under atmospheric pressure conditions.

7.2 Test conditions to determine concentration reduction performance

7.2.1 Temperature and relative humidity

The temperature in the test chamber should be set to 23 °C ± 1 °C, and relative humidity should be 50 % ± 5 % during the test.

For building materials with applications under other climatic conditions, alternative temperature and air humidity conditions may be used, preferably as specified in ISO 554. State the conditions in the test report.

To check the test material for temperature dependence of reduction performance, measurements under other climatic conditions may be applied.

Initial variations can be observed in the test chamber climate after opening the test chamber door and loading a test specimen. These variations should be recorded.

NOTE Temperature and relative humidity can affect area-specific reduction rate and re-desorption from the test material.

7.2.2 Supply air quality and background concentration

The background concentration of the supply air for the test chamber and the air prior to spiking with target compound(s) shall be low enough not to interfere with the test. The total VOC background concentration shall be lower than 20 µg/m^3. The background concentration of each VOC shall be lower than 2 µg/m^3. Purified water used for humidification shall not contain interfering VOCs that can affect the test.

7.2.3 Mass transfer coefficient

The mass transfer coefficient in terms of ambient air velocity over the surface of the test specimen inside the chamber shall be 15 m/h ± 3 m/h (equivalent to 0,25 m/s ± 0,05 m/s) when determined using water vapour. To check the dependence of the mass transfer coefficient on material performance, take measurements under conditions that appropriately influence the mass transfer coefficient.

NOTE 1 The mass transfer coefficient is analogous to the convective heat transfer coefficient where geometry and boundary conditions are similar. The mass transfer coefficient can be estimated with a formulation that relates the mass transfer flux (area-specific reduction rate) to a surface to the concentration differences across the boundary layer. For details concerning the mass transfer coefficient and its measurement method, see Reference [8].

NOTE 2 Reduction performance depends on the mass transfer coefficient. The mass transfer coefficient depends on the indoor concentration of the substance, air flow, and the surface area of the test specimen.

7.2.4 Air change rate

The air change rate shall be kept constant at 0,50/h ± 0,03/h changes per hour. The product-loading factor shall comply with ISO 16000-9, or be derived from the geometry and volume of an appropriate model room.

NOTE The selection of air flow rate per area, $q_{V,\,a}$, affects the steady-state concentration of target VOCs in the chamber air.

For comparison of results from different test chambers, the air exchange rate, n, and the product-loading factor, L, shall be the same for each chamber. The air change rate, n, and the product-loading factor, L, may affect the area-specific reduction rate, q_{ads}.

7.2.5 Supply air concentration

The concentration of target compound(s) in spiked air in the test chamber shall be approximately equal to the WHO guideline concentration(s) specified in 3.6.

Other concentrations may be applied if relevant for the purpose of the test. This shall be stated explicitly in the report.

It is possible to execute the test using mixed gas that includes two or more target compound(s). In that case, the influence of interference shall be considered.

7.3 Factors affecting the concentration reduction performance

7.3.1 General

To evaluate the effects of temperature, humidity, and air contaminants on the target compound concentration reduction performance, modify each of these factors separately.

7.3.2 Temperature and humidity

To evaluate the effects of temperature on concentration reduction performance, the temperature in the test chamber should be set to 18 °C ± 1 °C, 23 °C ± 1 °C and 28 °C ± 1 °C. The relative humidity in the test chamber should be set to 25 % ± 5 %, 50 % ± 5 % and 75 % ± 5 %, with the temperature in the chamber and the supply air concentration in the chamber set as specified in 3.6 and 7.2.5.

7.3.3 Concentration of target compound(s) in spiked air

The concentration of target compound(s) in spiked air should be set to twice the guideline concentration specified in 7.2.5, and then to one-half of the guideline concentration, with the chamber temperature and relative humidity set as specified in 7.2.1.

7.3.4 Interfering gases

Various interfering gases are expected to exist in indoor environments, and their effect can be measured on the performance of test materials in reducing target compound(s) by measuring such performance while varying the concentration of each interfering gas.

8 Verification of test conditions

8.1 Monitoring of test conditions

Temperature, relative humidity and air flow rate shall be monitored and recorded continuously with instruments meeting the following accuracy specifications:

- temperature: ±0,5 °C
- relative humidity: ±3 %
- air flow rate: ±3 %

Temperature and relative humidity of air may be measured in the outlet of the chamber if the point of measurement ensures values are identical to those inside the test chamber.

8.2 Airtightness of test chamber

Airtightness of the test chamber should be checked regularly as specified in ISO 16000-9:

- by pressure drop measurements,
- by comparison of simultaneous measurement of flow rates at the inlet and the outlet ports, or
- by measuring tracer gas dilution measurements.

8.3 Air change rate in test chamber

The air change rate shall be regularly checked as specified in ISO 16000-9.

NOTE If the test is carried out in the outlet with an air flow meter that is not permanently installed, note that the back pressure introduced by the instrument can lower the flow rate through the chamber.

8.4 Efficiency of the internal test chamber air mixing

Determine the efficiency of the air mixing as specified in ISO 16000-9.

8.5 Recovery

Recovery tests shall be performed in the test chamber by introducing supply air with the same target compound concentrations as specified for the performance test and then comparing air measurement results at the outlet and inlet of the test chamber. Chamber concentrations shall be determined 72 h after starting the test and the consistency of recovery performance during the test should be confirmed. The mean recovery shall be greater than 80 % for the target compound(s). The value obtained by subtracting the mean recovery from 100 % indicates the adsorption capacity of the test chamber. The adsorption capacity of the test chamber itself shall be subtracted from the measured adsorption capacity. The results of the recovery test shall be reported (expected concentration versus measured concentration).

NOTE Sink effect, leakage or poor calibration can cause difficulties in meeting minimum requirements for the test.

9 Preparation of test chamber

The test chamber shall be cleaned in order to fulfil the requirements of 7.2. Cleaning can be done as follows.

- The inner surfaces of the test chamber are washed with a detergent.
- Two separate rinsings are performed with freshly distilled water.
- The test chamber is then dried and purged under test conditions.

The test chamber can also be cleaned by thermal desorption.

For cleaning of the chamber, an oven may be used to volatilize any aldehydes or VOCs on the internal walls of the test chamber. Alternative methods may be used instead of an oven.

10 Preparation of test specimens

After completing test preparations, supply air spiked with the target compound(s) to the test chamber. Take a sample of the material to be tested from its package. The sample shall be a part or piece that is representative of a building material. Prepare a test specimen from the sample as specified in ISO 16000-11.

For the measurement of target compound sorption by only one surface of a test specimen, seal the cut edges and the back of the specimen with aluminium foil or other sealing material, or place two test specimens back-to-back with sealed edges.

11 Test method

11.1 Background concentration and spiked supply air

Prior to beginning a test, ventilate the test chamber for 1 day by running empty, and then measure and determine the background target compound concentrations of the empty test chamber.

The background concentration shall be low enough not to affect the test.

Then start flushing the test chamber with air spiked with target compound(s). Allow at least five air exchanges before introducing the test specimen.

11.2 Placing the test specimen in the test chamber

Place the test specimen in the middle of the test chamber to ensure that air can uniformly flow over the sorbing surface of the test specimen. Close the chamber. Note the time as the start of the test.

The test specimen shall be placed in the test chamber as quickly as possible.

11.3 Time intervals for measurement of chamber concentration

11.3.1 Test for concentration reduction performance

After the start of the test, sample air from the chamber inlet and the chamber outlet in accordance with 11.4 at predefined elapsed times.

Measure the quantity of target compound(s) removed from the test chamber air per area of the test specimen exposed to the chamber air under the measuring conditions specified in 7.2.

Check the total air flow through the test chamber and ensure that there is no air leakage from it. Then, ensure that the outlet air flow rate during air sampling is equal to the inlet air flow rate minus the sum of the sampling air flow rates. The remaining outlet airflow rate shall be at least 20 % of the total sampling air flow rates. Air samples shall be taken 24 h ± 2 h, 72 h ± 6 h, 168 h ± 14 h, 14 days ± 1 day, and 28 days ± 2 days after the start of the test. Additional air samples may be collected. Duplicate sampling should be conducted. Other time intervals may be selected according to the purpose of the test. If data on long-term performance of the test material are required, air sampling shall be done over 28 days after the test start. When the reduction performance decreases to one-half of the initial value, terminate the test.

The stability of the spiked concentration(s) at the air inlet shall be monitored.

A subsequent test of re-emission should be conducted by supplying clean air to the test chamber. It is preferable to undertake re-emission tests routinely as part of the reduction performance test. Air samples should be taken 24 h (and other times if required) after the start of the re-emission test. In cases where significant sorption of VOCs to chamber surfaces occurs, the relative contribution of the sample and the chamber walls to the total emission shall be assessed. This may be achieved by conducting appropriate control tests without material samples.

If VOCs and other organic compounds are emitted from the material sample, measure their emission rates as described in ISO 16000-3, ISO 16000-6 and ISO 16000-9.

11.3.2 Test for long-term reduction performance

Measure the half-lifetime, and then measure the total mass per area of sorption, ρ_{Ac}, of VOCs and the elapsed time, $t_{e.}$ The value after 24 h shall be used for initial concentration.

11.3.3 Factors affecting the reduction performance

The effect of each environmental factor may be measured by varying the value of only one factor at a time against those conditions used for the measurement of the reduction performance in 11.3.1. The measuring conditions shall be as specified in 7.2.

11.4 Air sampling

Tenax TA®[1] (2,6-diphenyl-*p*-phenylene-oxide polymer resin) or another appropriate sorbent tube as specified in ISO 16000-6 and ISO 16017-1 shall be used for air sampling for the determination of VOC concentration.

12 Determination of target compound(s)

The analysis method of target VOCs shall be as specified in ISO 16000-6 and ISO 16017-1.

13 Expression of results

13.1 Calculation of area-specific reduction rate

Calculate the area-specific reduction rate per time unit per area at the elapsed time t_e, $\rho_{\text{ads},\,te}$, using Formula (1):

$$\rho_{\text{ads},t_e} = \frac{\left(\rho_{\text{in},\,t_e} - \rho_{\text{out},\,t_e}\right) q_c}{A} \tag{1}$$

---

[1] Tenax TA® is the trade name of a product manufactured by Supelco, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

where

$\rho_{\text{in},\,te}$ is the concentration of target compound(s) at test chamber inlet at elapsed time, t_e;

$\rho_{\text{out},\,te}$ is the test chamber concentration at elapsed time, t_e;

q_c is the air flow rate in the test chamber;

A is the surface area of test specimen.

13.2 Calculation of equivalent ventilation rate per area

Assuming that the concentration falls due to increasing air flow rate of clean air, calculate the equivalent ventilation rate per area at the elapsed time t_e, $q_{V,\,\text{eq}}$, using Formula (2):

$$q_{V,\text{eq}} = \frac{\left(\frac{\rho_{\text{in},t_\text{e}}}{\rho_{\text{out},t_\text{e}}} - 1\right) q_\text{c}}{A} \tag{2}$$

13.3 Calculation of total mass per area of sorption and saturation mass per area

Calculate the total mass per area of sorption, $\rho_{A\text{c}}$, at the half-lifetime, applying Formula (3):

$$\rho_{A\text{c}} = \int_0^{t_\text{e}} \left(\rho_{\text{ads},t}\right) \text{d}t \tag{3}$$

where t_e is elapsed time.

The saturation mass per area, $\rho_{A\text{a}}$, is given by the identity:

$$\rho_{A\text{a}} \equiv \rho_{A\text{c}}$$

14 Test report

The test report shall include at least the following information:

a) test laboratory:
   1) name and address of the test laboratory,
   2) name of the responsible person;

b) sample description:
   1) type of building material (and brand name, if appropriate),
   2) sample selection process (e.g. random),
   3) product history (date of production, batch number, date of arrival at the test laboratory, date and time of unpacking, date and time of preparation of test specimen, etc.);

c) test results:
   1) area-specific reduction rate of target compound(s), total mass per area of sorption, the equivalent ventilation rate per area at the half-life time and other specified elapsed time,

   2) the saturation mass, and the reduction performance in the presence of interfering gases,
   3) details of the method used, with reference to this document, i.e. ISO 16000-24:2018,

d) test conditions:
   1) test chamber conditions [temperature, relative humidity, air change rate, mass transfer coefficient, concentration of target compound(s) in spiked air],
   2) surface area of the test specimen and loading factor,
   3) whether the test specimen was sealed (and how),
   4) information on air sampling (sampling tube used, volume of air sampled, air sampling period from the test start, the number of air samplings, etc.),
   5) test conditions for long-term performance test [temperature, concentration of target compound(s) in spiked air];

e) devices: information on the equipment and procedure (test chamber, sealing material or sealing box, method of spiking the supply air, air purifier, temperature and humidity controls, air flow meter, air sampling devices, analytical instrument, etc.);

f) quality control/quality assurance (details are as specified in Annex B):
   1) background concentration of formaldehyde and other carbonyl compounds and VOCs,
   2) recovery data of target compound(s),
   3) number of measurements,
   4) result of each analysis of air sampled, if duplicate sampling was undertaken,
   5) accuracy of temperature, relative humidity and air change rate,
   6) quality assurance report;

g) additional details for test materials such as paints, coatings, or plastering materials:
   1) number of test specimens,
   2) mass per area,
   3) thickness,
   4) other observations that can influence the test results (drying conditions, storage, preservation, moisture content, surface treatment),
   5) applied mass per area, in grams per square metre,
   6) area,
   7) method used.

Annex A
(normative)

Sample tube test for long-term reduction performance

A.1 Principle

A.1.1 General

If a test material has a reduction performance greater than, for example, 28 days, meaning that a chamber test would take too long, a sample tube test for determining $\rho_{A\mathrm{a}}$ may be applied, based on the physical sorption, chemisorption, and decomposition reaction.

The sample tube test for long-term target compound reduction performance is the method to estimate the sorption capacity, w_S.

NOTE In many cases, the value of $\rho_{A\mathrm{c}}$ is less than w_S. Therefore, $\rho_{A\mathrm{a}}$ estimated by the routine chamber test is less than the value of $\rho_{A\mathrm{a}}$ estimated by the sample tube test.

A.1.2 Target compound reduction by physical sorption

The saturation mass per area, $\rho_{A\mathrm{a}}$, shall be calculated from the sorption capacity, w_S, which is measured by passing air containing target compound(s) through a glass sample tube filled with a small mass of finely ground (2 mm diameter or less) test specimen at breakthrough time.

A.1.3 Target compound reduction by chemisorption and/or decomposition reaction

The saturation mass per area, $\rho_{A\mathrm{a}}$, shall be calculated from the sorption capacity, w_S, which shall be measured as specified in A.1.2.

Chemisorption and/or decomposition can be calculated when the chemical reaction scheme is widely known.

The composition of the chemical substance shall be known in this case, because the molar concentration of the sorption agent employed is used in the calculation. Therefore, this method is not applicable to natural materials with unknown composition.

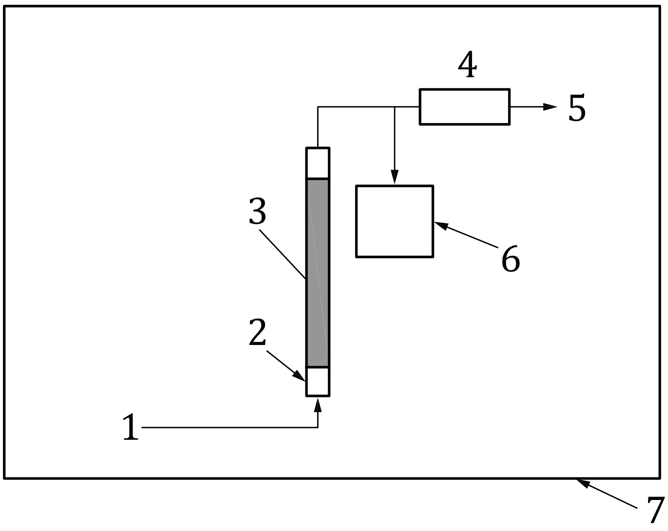
Any calculation of long-term reduction performance by experimental data (testing) should be confirmed.

Alternatively, evaluation by calculation of chemical reaction between sorption agent and target compound(s) may be performed.

A.2 Apparatus and materials

The usual laboratory apparatus, and, in particular, the following.

See Figure A.1 for a typical setup.



Key

1	inlet air
2	sample tube
3	ground test specimen
4	air flow meter
5	outlet air
6	target compound detector
7	climate chamber

Figure A.1 — Example of apparatus to evaluate concentration reduction performance

A.2.1 Sample tube, which fits the testing system and which can accommodate the test specimen. The sample tube is installed so that its length is vertical.

A.2.2 Supply air spiked with target compound(s), complying with 6.4.

A.2.3 Temperature monitoring apparatus, complying with 6.5.

A.2.4 Air flow meter, installed before the sample tube or behind the air sampling pump for measuring the target compound air flow. Other devices may be used if they have equal or better performance.

A.2.5 Target compound detector, installed at the outlet of the sample tube. It should be able to detect the target compound(s) at 0,5 % of the concentration in the supply air. For example, thermal conductivity detectors or mass spectrometry may be used. Target compound detectors may be applied only after calibration of their response. Tenax TA® tubes may also be installed at the outlet of the sample tube to collect air samples at appropriate time intervals.

A.2.6 Climate chamber, in which the sample tube shall be contained. The climate chamber shall be a chamber controlled to the required temperature ±2,0 °C.

A.3 Test conditions

A.3.1 Supply air concentration

The total concentration of target compound(s) spiked into the supply air in the sample tube should be approximately equal to the guideline concentration.